Comparison of methods to derive radial wind speed from a continuous-wave coherent lidar Doppler spectrum

Continuous-wave (cw) lidar systems offer the possibility to remotely sense wind speed but are also affected by differences in their measurement process compared to more traditional anemometry like cup or sonic anemometers. Their large measurement volume leads to an attenuation of turbulence. In this paper we study how different methods to derive the radial wind speed from a lidar Doppler spectrum can mitigate turbulence attenuation. The centroid, median and maximum methods are compared by estimating transfer functions and calculating root mean squared errors (RMSEs) between a lidar and a sonic anemometer. Numerical simulations and experimental results both indicate that the median method performed best in terms of RMSE and also had slight improvements over the centroid method in terms of volume averaging reduction. The maximum, even though it uses the least amount of information from the Doppler spectrum, performs best at mitigating the volume averaging effect. However, this benefit comes at the cost of increased signal noise due to discretisation of the maximum method. Thus, when the aim is to mitigate the effect of turbulence attenuation and obtain wind speed time series with low noise, from the results of this study we recommend using the median method. If the goal is to measure average wind speeds, all three methods perform equally well.

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